

Using Remotely Sensed Data to Inform Chesapeake Bay Restoration Policy Decisions

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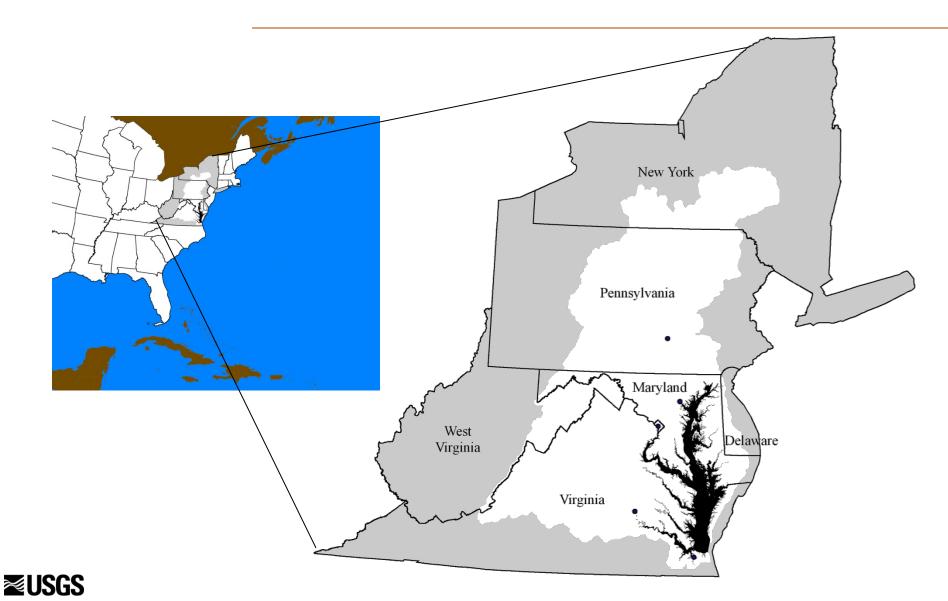
U.S. Department of the Interior U.S. Geological Survey

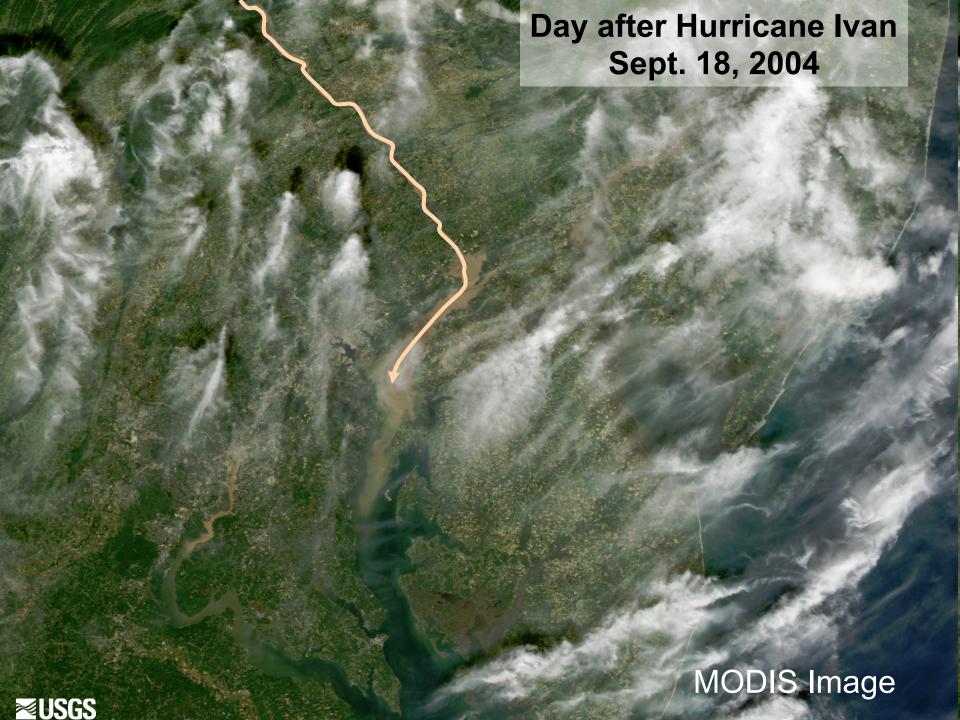
Presentation Outline

- 1. The Chesapeake Bay Restoration Effort
- 2. Decisions Informed by Remote Sensing Data
- 3. From Data to Decisions
- 4. Future Directions

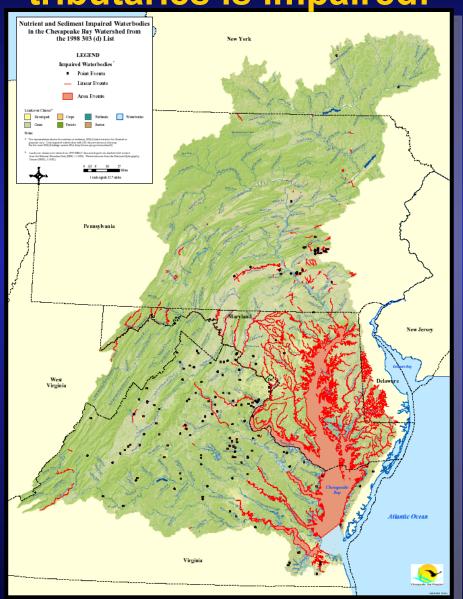


Study Area: Chesapeake Bay Watershed, U.S.A.



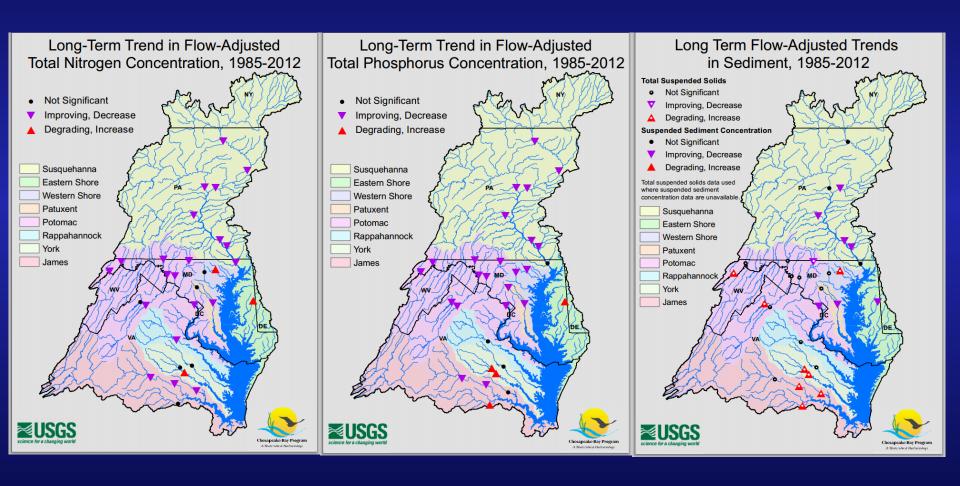


Water quality in the Bay and 90% of its tidal tributaries is impaired!



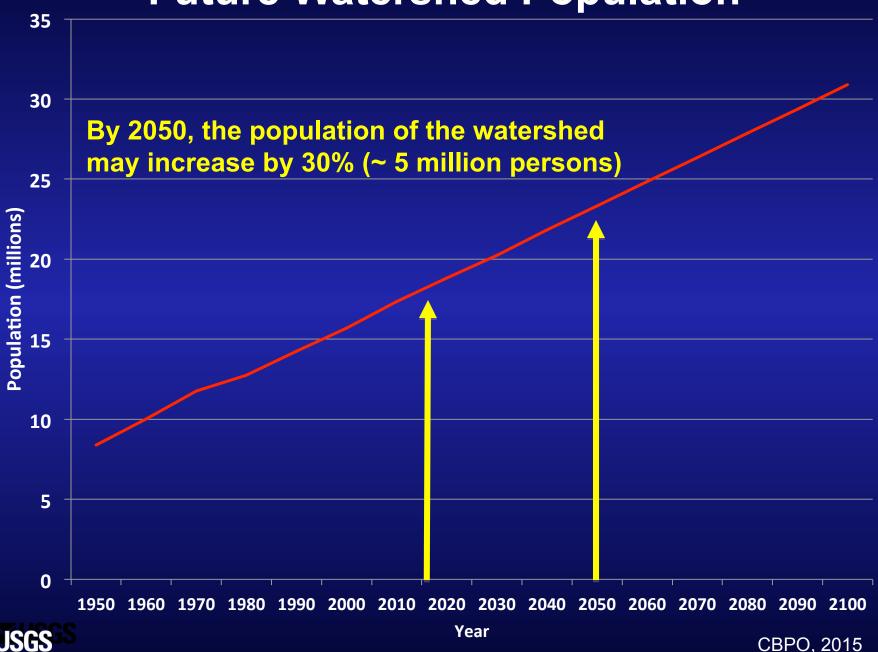


Over almost 3 decades, water quality has improved in some areas.





Future Watershed Population





Chesapeake 2000 Agreement





"By 2001, complete an assessment of the Bay's resource lands including forests and farms, emphasizing their role in the protection of water quality and critical habitats, as well as cultural and economic viability."

tion. These challenges are further complicated by the dynamic nature of the Bay and the ever-changing global ecosystem with which it interacts.

In order to achieve our existing goals and meet the challenges that lie ahead, we must reaffirm our partnership and recommit to fulfilling the public responsibility we undertook almost two decades ago.

"By 2012, reduce the rate of harmful sprawl development of forest and agricultural land in the Chesapeake Bay watershed..."

reflects the Bay's complexity in that each action we take, like the elements of the Bay itself, is connected to all the others. This Agreement responds to the problems facing this magnificent ecosystem in a comprehensive, multifaceted way.

Bay THIS AGREEMENT, we commit ourselves to nurture and sustain a Chesapeake Bay Watershed Partnership and to achieve the goals set forth in the subsequent sections. Without such a partnership, future challenges will not be met. With it, the restoration and protection of the Chesapeake Bay will be ensured for generations to come.



2010 Bay Total Maximum Daily Load (TMDL)

Chesapeake Bay Total Maximum Daily Load for Nitrogen, Phosphorus and Sediment

A TMDL is essentially a "pollution diet" that identifies the maximum amount of a pollutant the waterway can receive and still meet water quality standards.

> U.S. Environmental Protection Agency Region 3 Chesapeake Bay Program Office Annapolis, Maryland

> > and

The Diet: 25 percent reduction in nitrogen, 24 percent reduction in phosphorus and 20 percent reduction in sediment.

U.S. Environmental Protection Agency
Office of Water
Office of Air and Radiation
Office of General Counsel
Office of the Administrator
Washington, D.C.

and in collaboration with

Delaware, the District of Columbia, Maryland, New York, Pennsylvania, Virginia, and West Virginia



The Bay TMDL

- 1. Implementation of actions to restore the Bay are planned to take 10 more years (2015 2025).
- 2. Ecosystem responses to those actions may take <u>decades</u> due to groundwater lag times and other factors.
- 3. By 2050, the population of the watershed may increase by 30% (~ 5 million persons); and
- 4. EPA expects that <u>ALL</u> new or increased loadings of nitrogen, phosphorous and sediments will be offset by reductions and credits generated by other sources.



Chesapeake 2014 Agreement

GOALS & OUTCOMES

- Sustainable Fisheries
- Vital Habitats
- Water Quality
- Toxic Contaminants
- Healthy Watersheds
- Stewardship
- Land Conservation
- Public Access
- Environmental Literacy
- Climate Resiliency

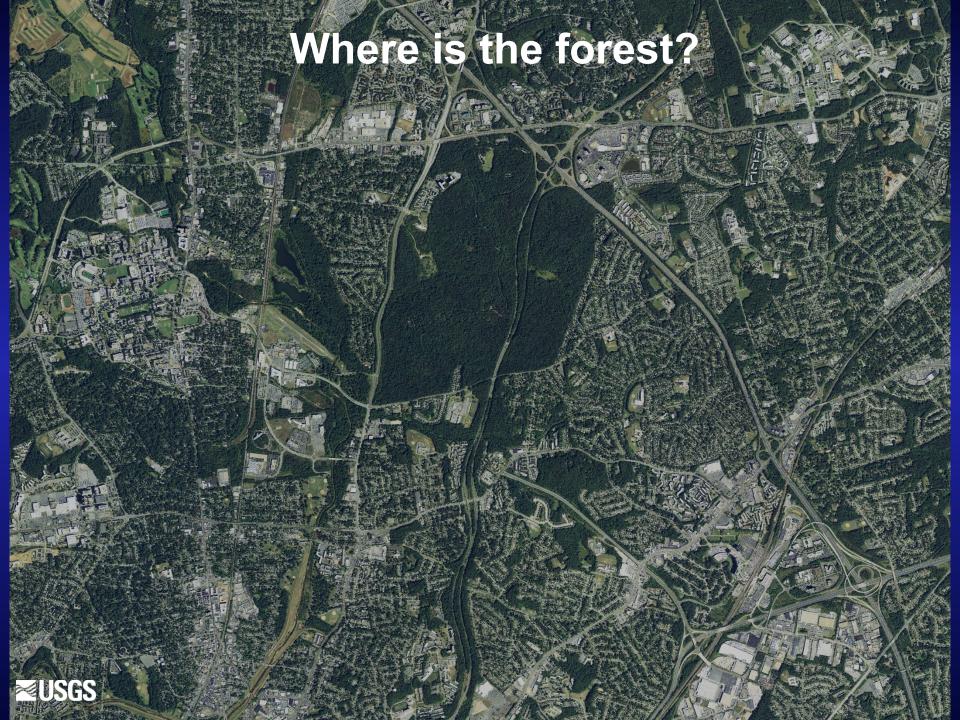


Chesapeake Bay Decisions & Remote Sensing Data

- 1. Increase the proportion of "forests" along "streams" from 60% to 70% throughout the watershed.
- 2. Expand "urban tree canopy" by 2,400 acres by 2025.
- 3. Characterize the rate of "impervious surface" change at a scale relevant to County-level decisions.
- 4. Assess the vulnerability of "healthy watersheds" to land use and climate change.
- 5. Achieve and sustain 185,000 acres of "Submerged Aquatic Vegetation".
- 6. Create or re-establish 85,000 acres of "wetlands".

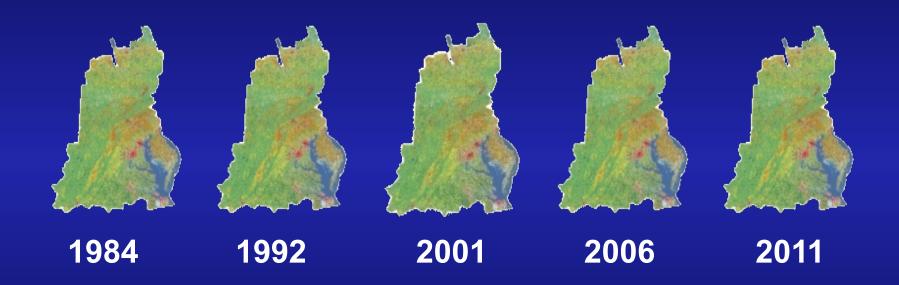






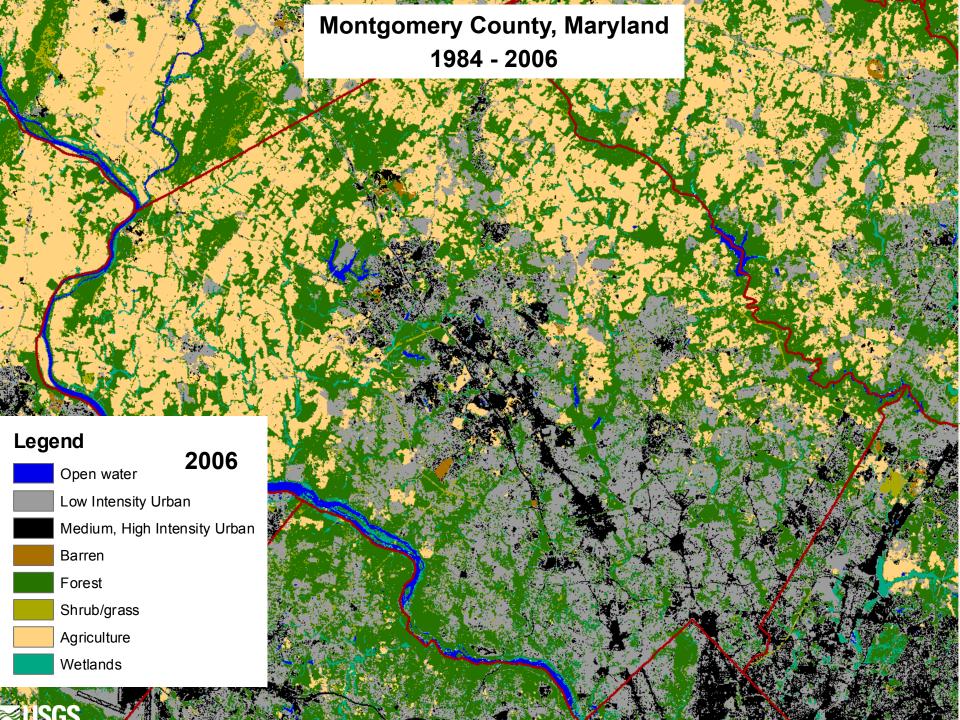


Chesapeake Bay Land Cover Data Series



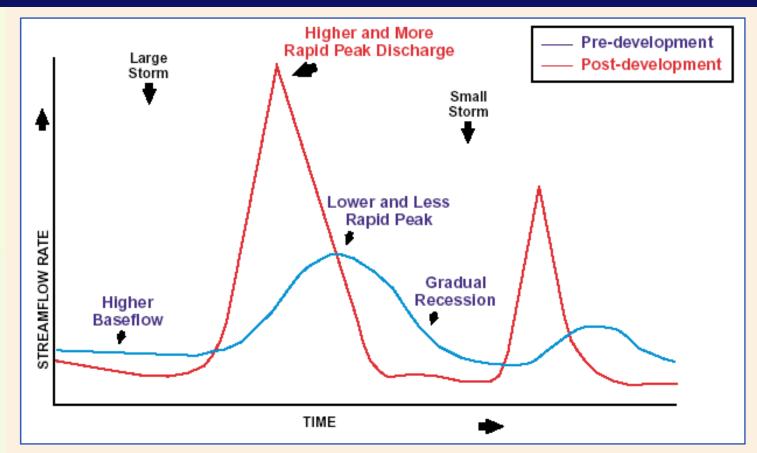
Irani, F. M., & Claggett, P. (2010). Chesapeake Bay Watershed Land Cover Data Series. *US Geological Survey Data Series*, *505*.







What are the impacts of development on stream flow?



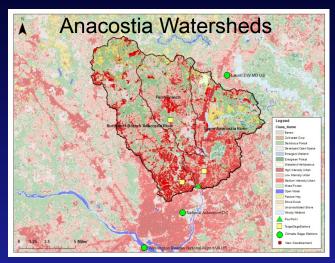
An altered hydrograph, typical of watersheds under the influence of impervious surface area.

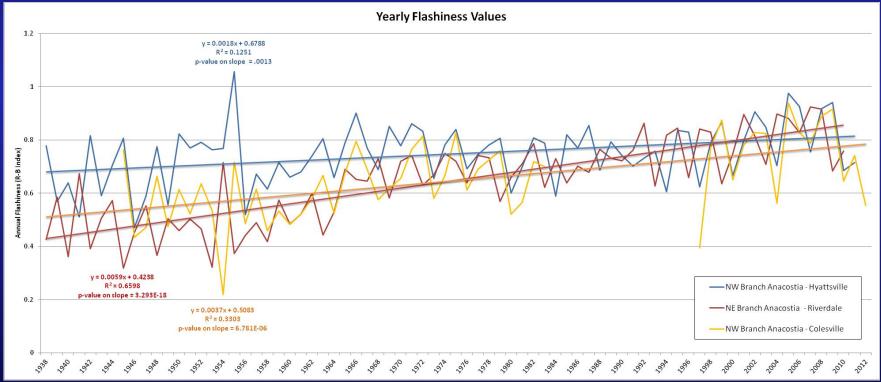
K. Rice, USGS

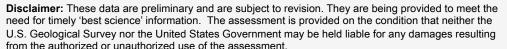




Assessing the Impact of Impervious Surface on Stream Flow









Estimating Impervious Cover and Turf Grass in the Chesapeake Bay Watershed

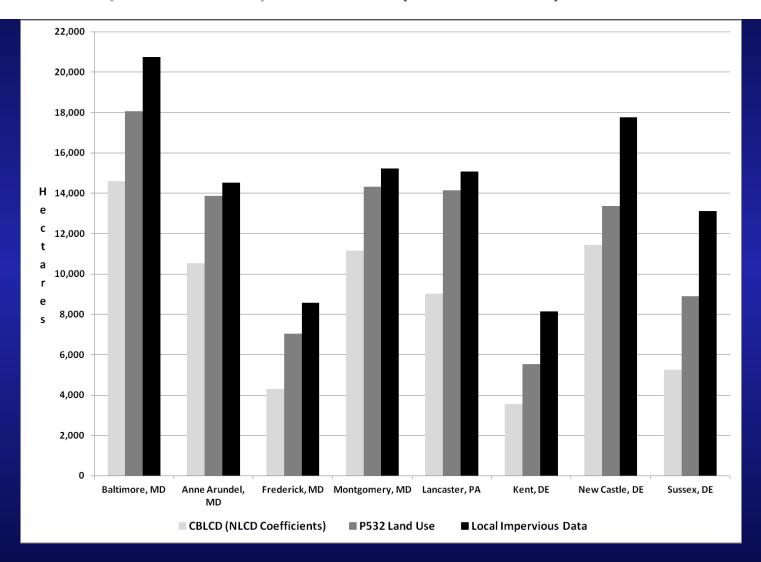
Model Version	Impervious Surface	Pervious Surface
	(circa 2001/02)	(circa 2001/02)
CBLCD (land cover)	809,318	2,341,577
Phase 5.3.2 (land use)	1,269,030	3,398,732

Claggett, P. R., Irani, F. M., & Thompson, R. L. (2013). Estimating the extent of impervious surfaces and turf grass across large regions. *JAWRA Journal of the American Water Resources Association*, 49(5), 1057-1077.



County-level Impervious Surface Estimates

Landsat (Phase 5.3.0), Modeled (Phase 5.3.2), and Local Data





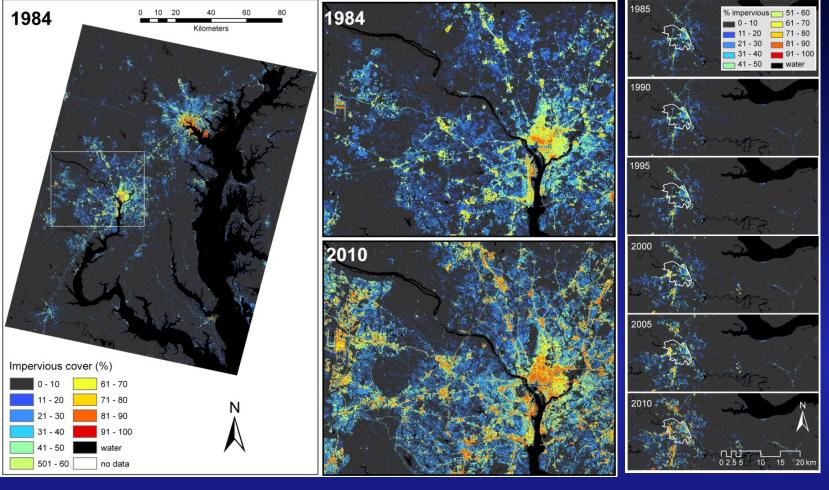
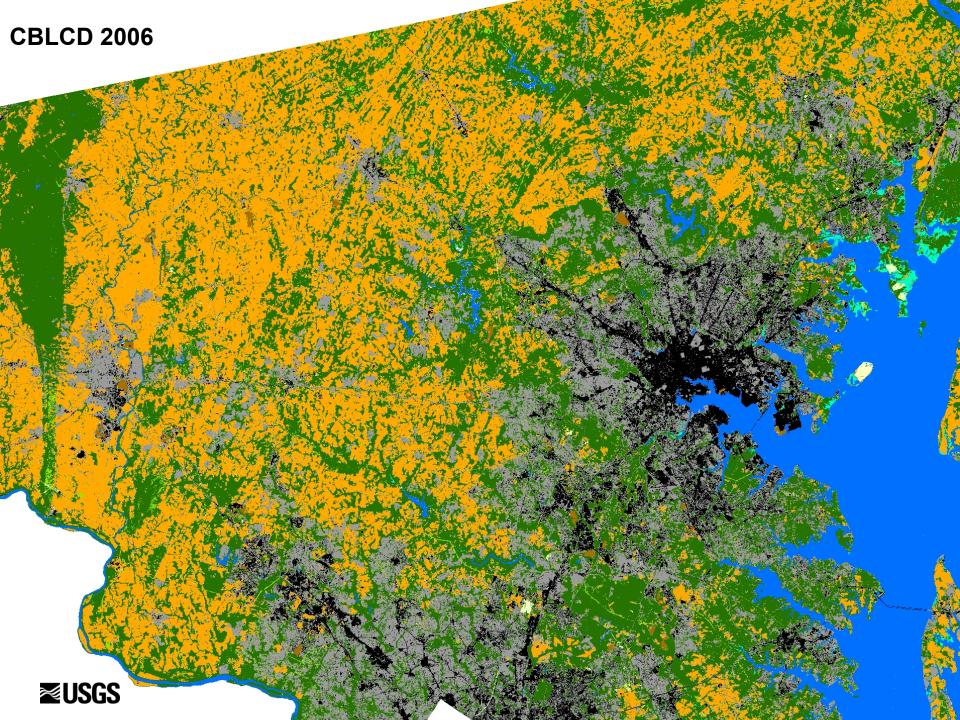


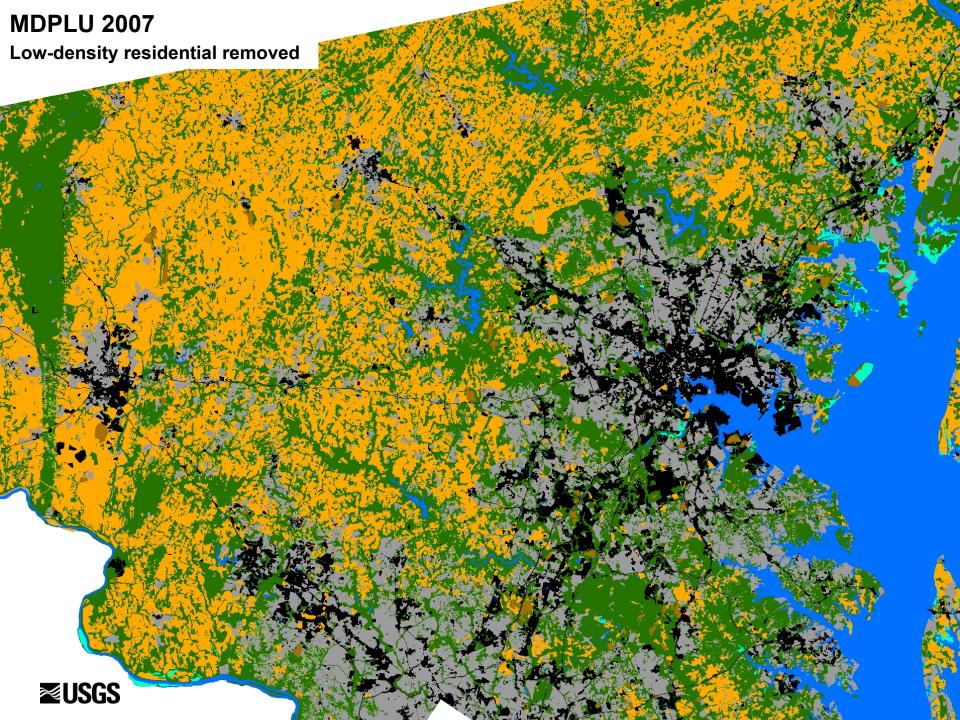
Figure 1. Dynamic Impervious Surface Cover Observations (DISCO) for the DC-Baltimore metropolitan area in 1984 (*left*), the Northern Virginia suburbs in 1984 and 2010 (*center*), and Fredericksburg, VA from 1985 to 2010 (*right*).

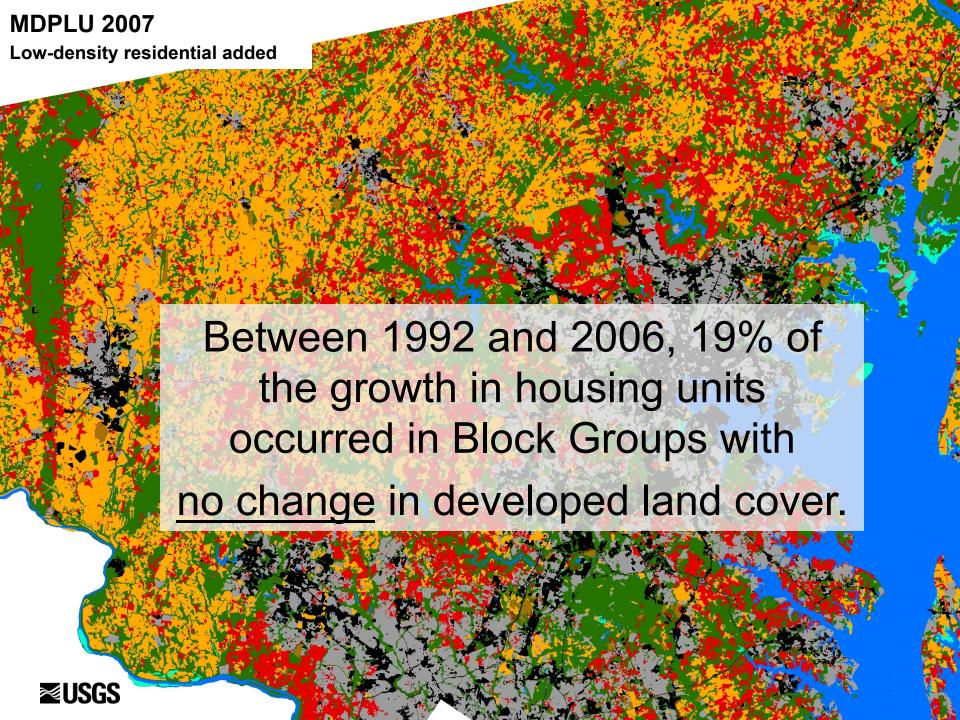
Sexton et al., 2013.

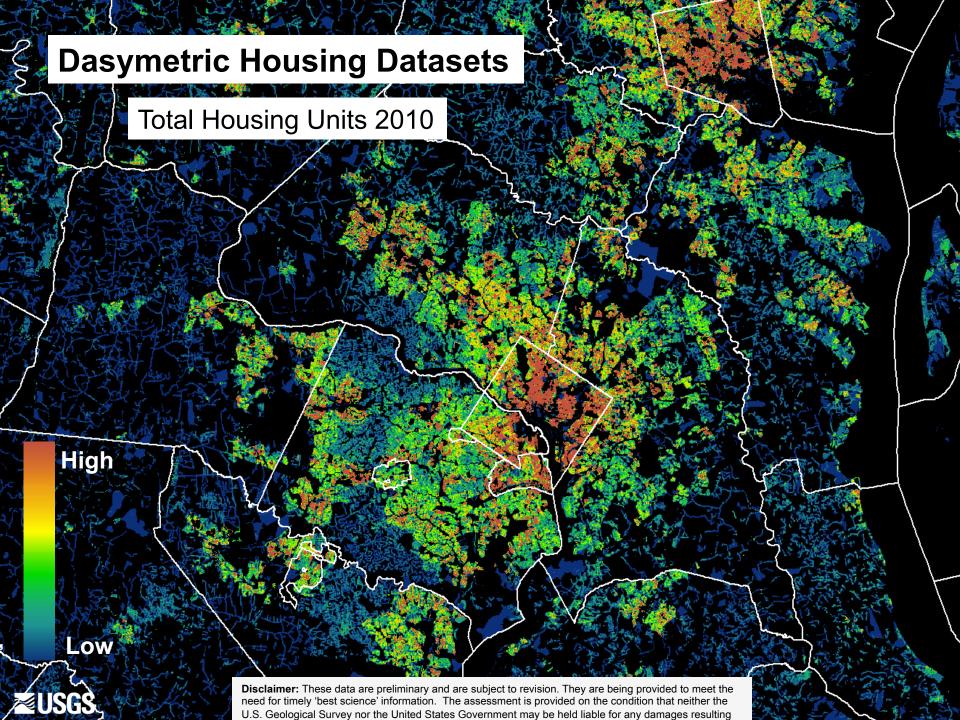
Scene	Summer images	Winter images
P014r032	117	63
P014r033	145	78
P014r034	146	90
P015r032	128	60
P015r033	140	82
P015r034	141	93
P016r032	121	49
P016r033	127	81
P017r032	121	29
P017r033	115	37

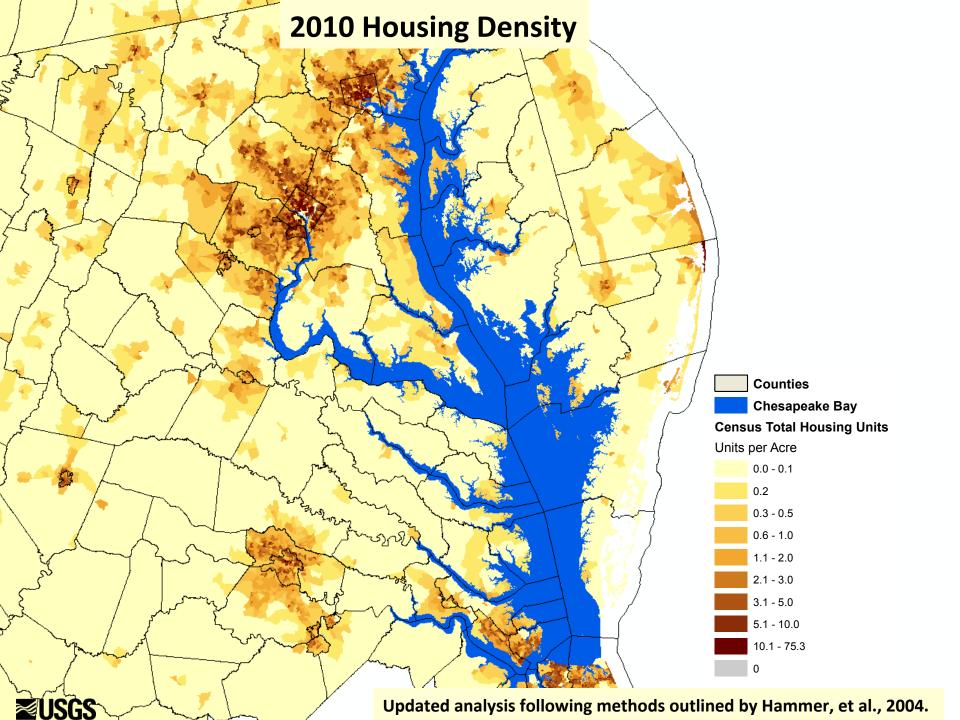


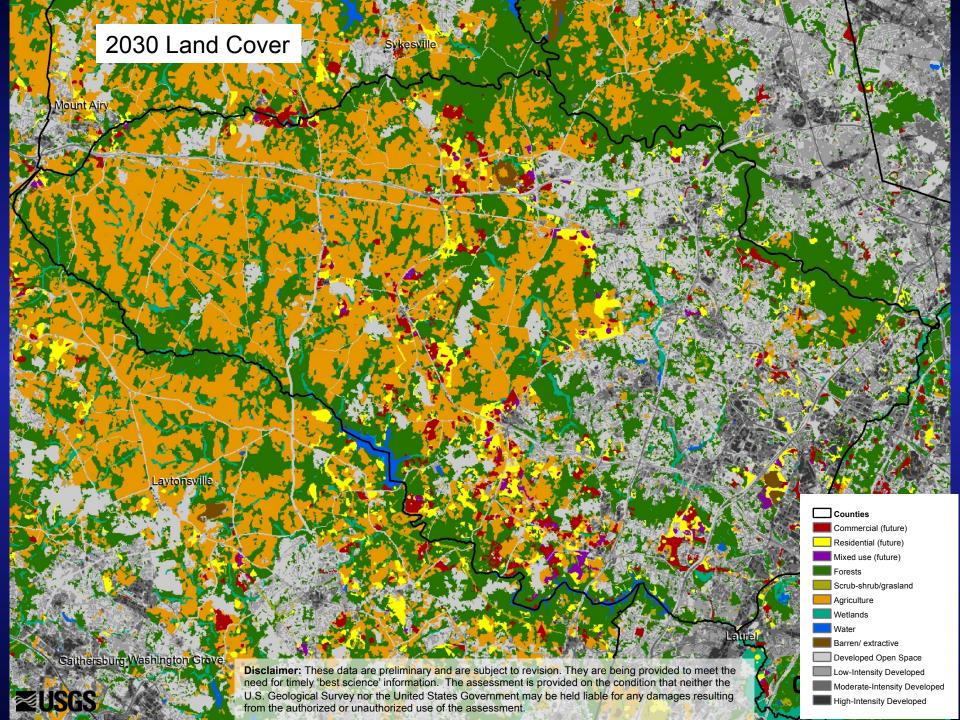


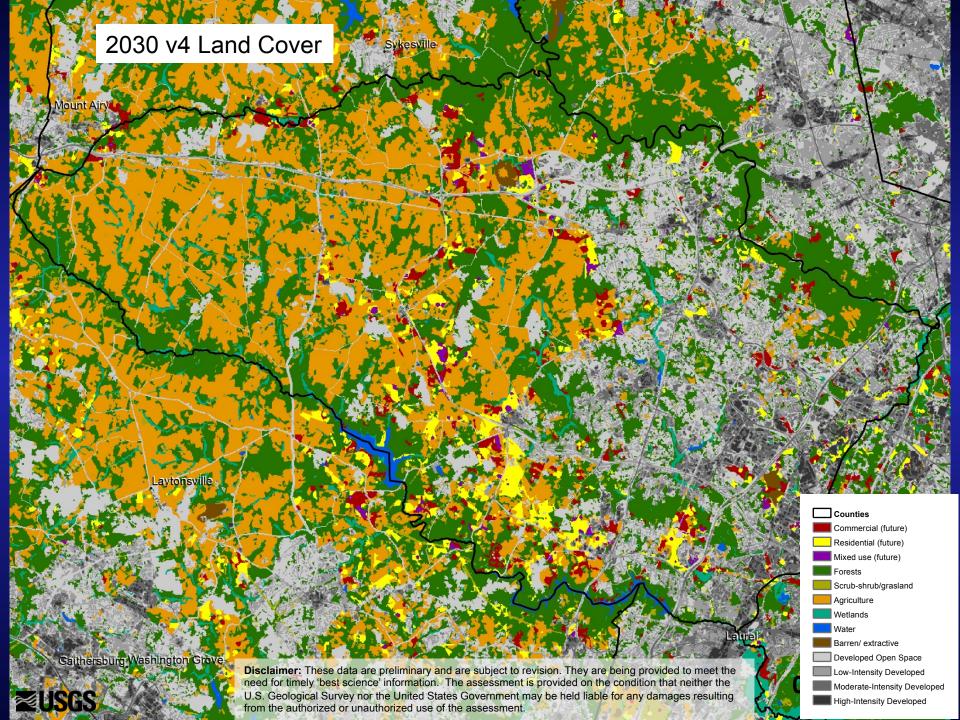


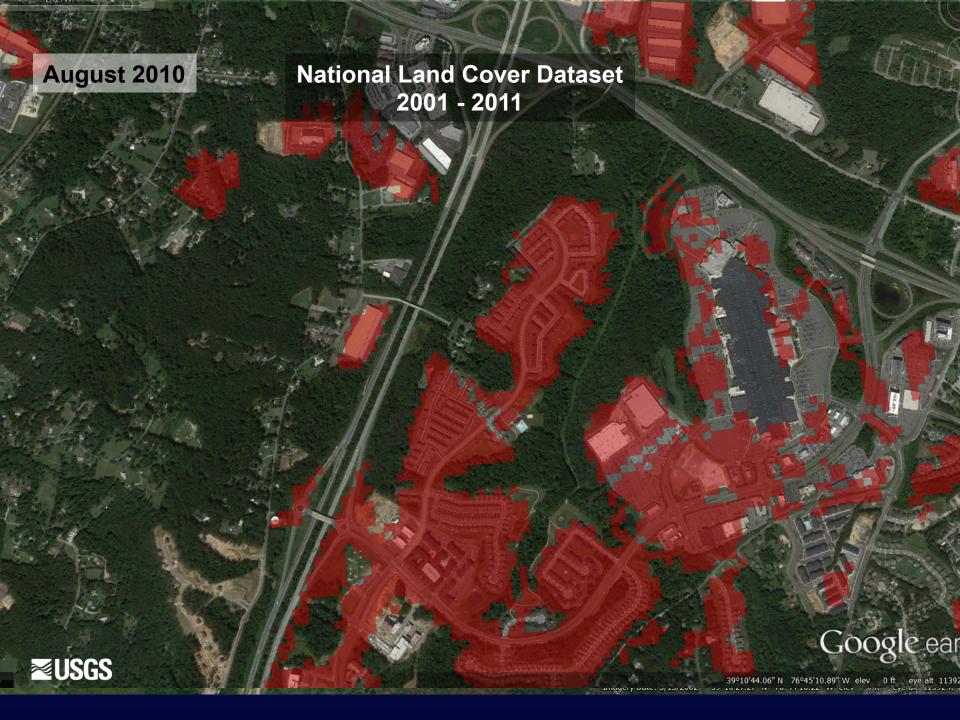






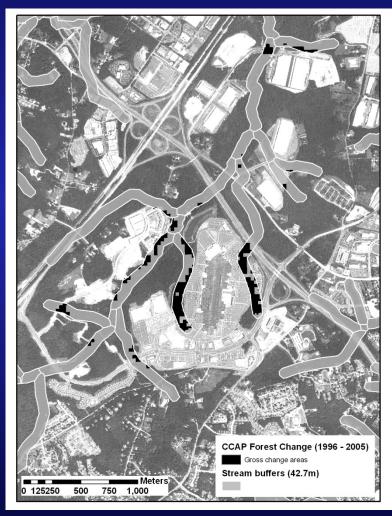


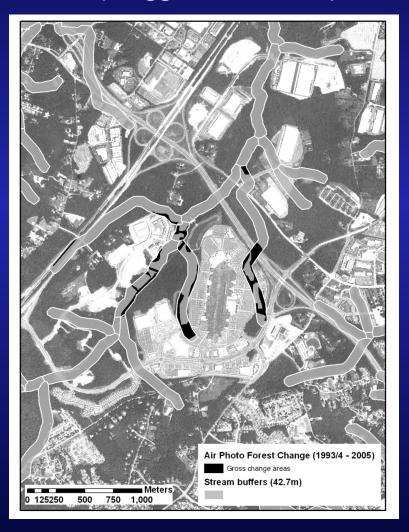




Assessing Riparian Forest Buffer Change

1.83% (SE 0.22%) Gross Forest Change in Anne Arundel County 1994 – 2005 Air Photo Interpretation (Claggett et al., 2010)

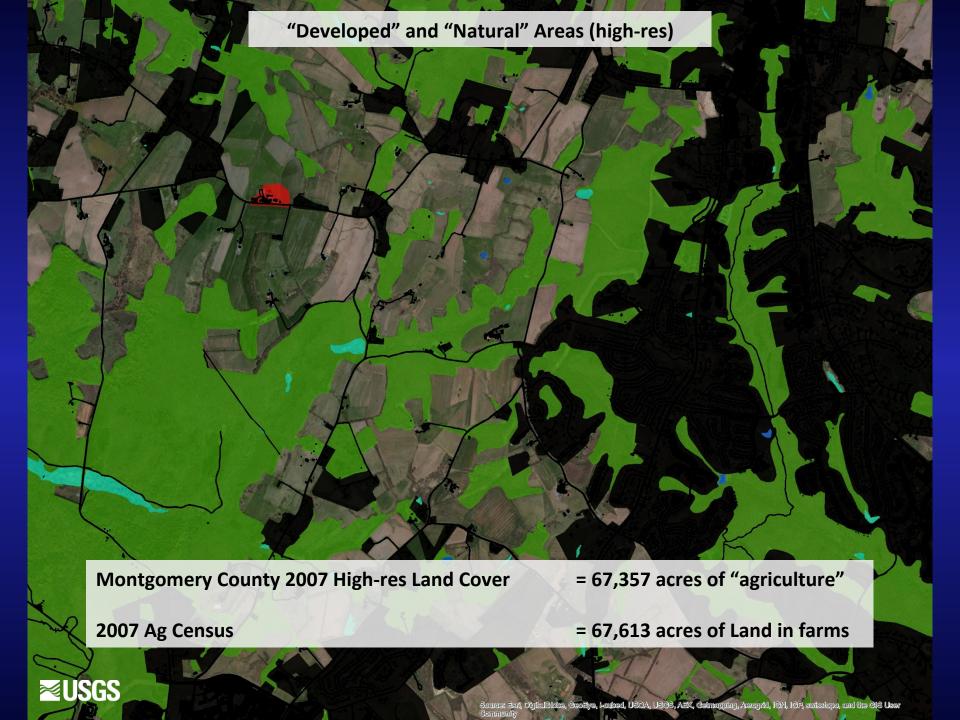


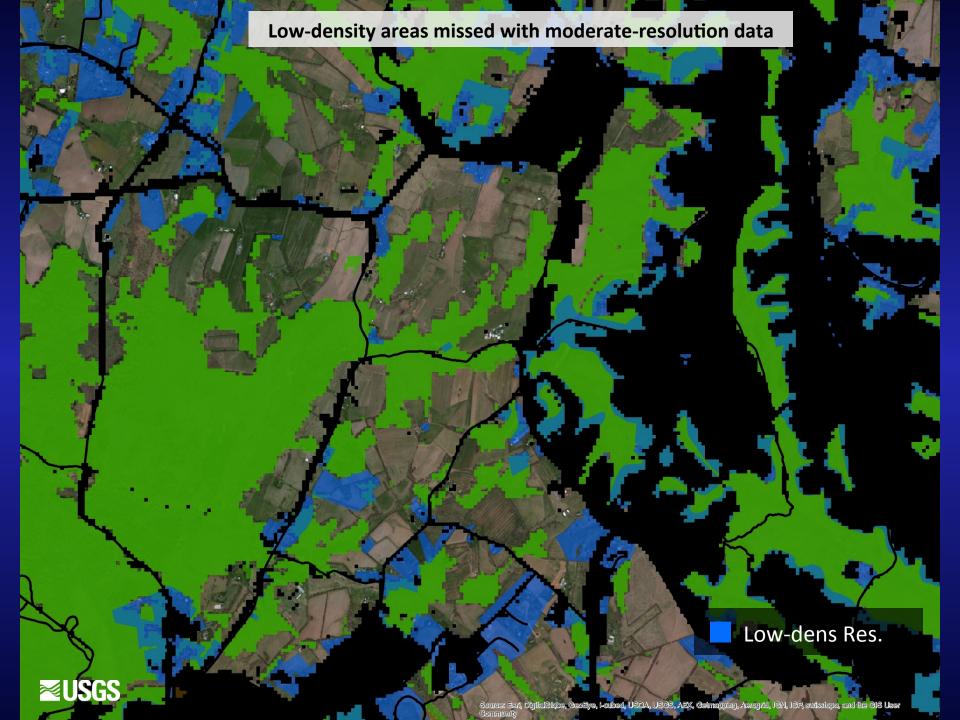


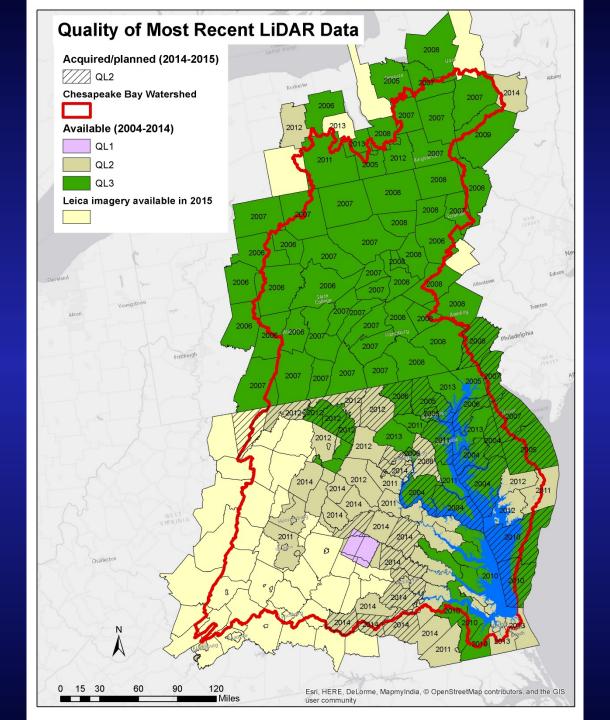






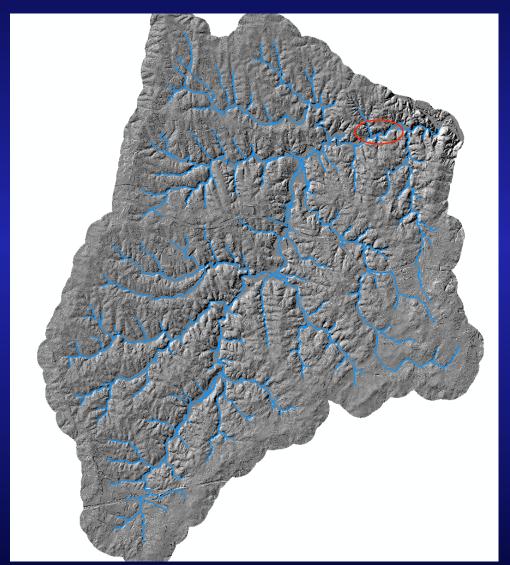








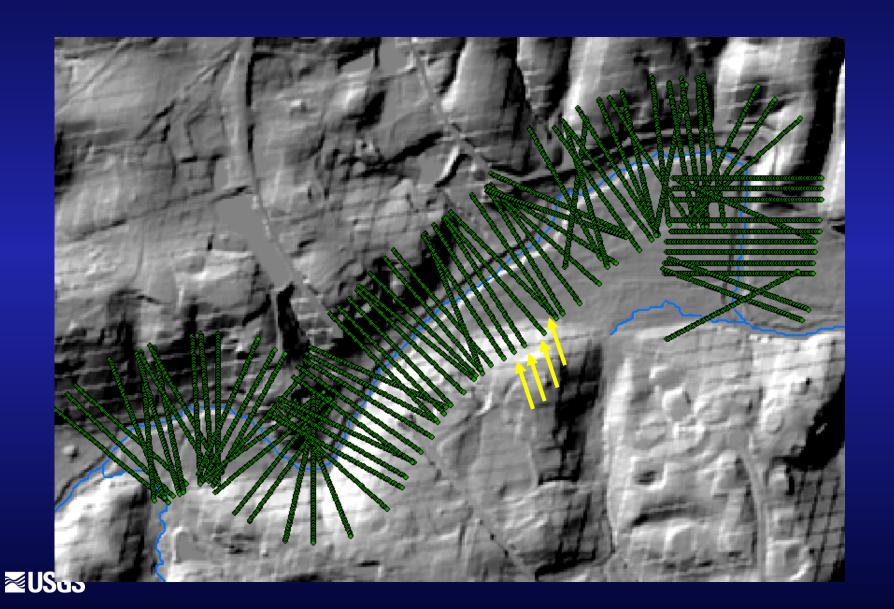
Extracting Stream Channel Geometry from LiDAR



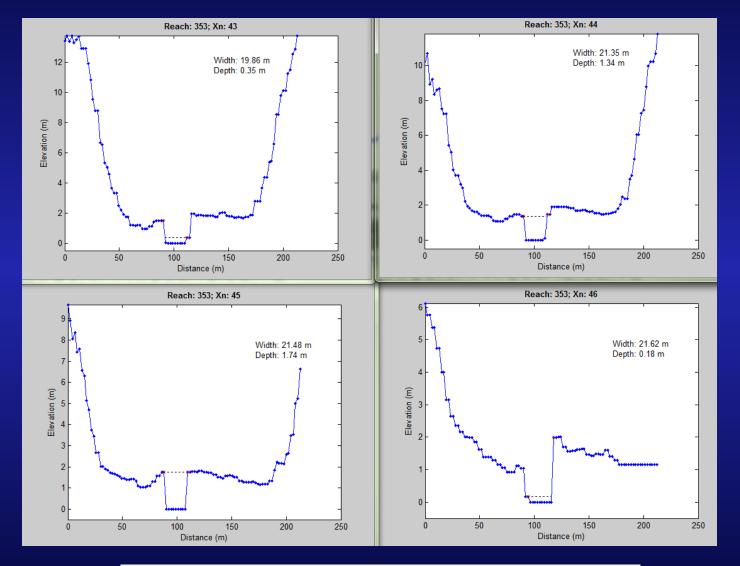
Difficult Run Watershed Fairfax County, VA



Automatic Stream Cross-Sections



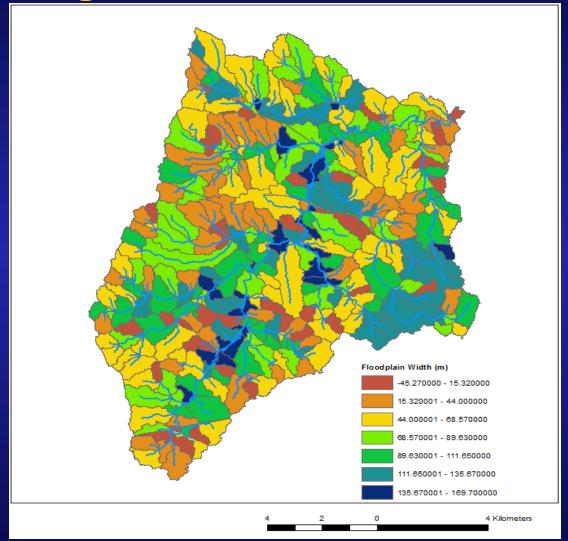
Automatic Cross-Sections





Disclaimer: These data are preliminary and are subject to revision. They are being provided to meet the need for timely 'best science' information. The assessment is provided on the condition that neither the U.S. Geological Survey nor the United States Government may be held liable for any damages resulting from the authorized or unauthorized use of the assessment.

Extrapolating Cross-sections to Watersheds





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Future Directions

- Monitoring high-resolution land cover and elevation change every 5 years.
- Monitoring land cover change annually and/or seasonally with Landsat.
- Characterizing hydrologic pathways in headwater catchments with LiDAR
- Remote sensing of water quality
- Remote sensing of biological carbon stocks



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